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Cost Effective LOGMARS Marking of the M16 Rifle

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The M16 family of rifles is by far the largest component of most Service armories. Because the number and use of M16 rifles vary by Service, the most effective strategy for etching them varies by Service. For those stored in crates out of use, we recommend that weapons not be etched until crate opening and issuance.

We recommend that the Army etch new M16A2s at Anniston Army Depot as they are received from the factory. Since the Army's entire inventory of older M16A1s is scheduled for replacement, we recommend that none of the currently fielded M16A1 inventory be etched.

The Marine Corps and the Air Force should engage jointly in a program of etching M16s at installations with large inventories. They should use a truck-mounted mobile etcher. The M16s assigned to Edwards Air Force Base can be etched at a lower cost at Hill Air Force Base's small arms repair facility.

The Navy has a relatively small number of M16 rifles, and most of them are stored in crates. Uncrated M16s are so few that they do not justify a laser etching program.

We recommend, in future small arms procurements, arrangements for etching by the manufacturer.

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COST EFFECTIVE LOGMARS MARKING OF THE M16 RIFLE

Report MC601R2

March 1987

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Prepared pursuant to Department of Defense Contract MDA903-85-C-0139.

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Executive Summary

COST EFFECTIVE LOGMARS MARKING OF THE M16 RIFLE

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CHAPTER 1

INTRODUCTION

BACKGROUND

In 1982 the U.S. Air Force undertook a technical study for the Department of Defense LOGMARS[1] Coordinating Group to determine whether bar codes could be permanently etched into small arms and other items and be read by commercially available hand-held scanners. That study[2], completed in 1984, indicated that using a laser to etch bar codes on small arms is not only technically feasible but also produces a durable, readable permanent marking. The U.S. Marine Corps, encouraged by the study results, decided to base the development of automated small arms tracking and inventory control systems on the use of laser etched weapon bar codes. In support of that effort, the Office of the Assistant Deputy Chief of Staff for Installations and Logistics, Headquarters, U.S. Marine Corps, conducted a small arms application study in May 1986 and concluded that substantial cost savings could be realized with automated inventory systems based on bar code data entry.[3]

This type of bar code tracking and inventory control system is straightforward and inexpensive to develop. What is not known is whether laser etching bar codes on the hundreds of thousands of Marine Corps weapons is cost-effective and if it is, exactly what data should be coded on the weapons. At issue are weapons in current inventories (such as the M16 family of rifles) and those weapons (such as the M9 pistol) that have yet to be fielded.

The other Services have displayed considerable interest in the Marine Corps answer to these questions in anticipation of the fielding of their own automated

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[1]Logistics Applications of Automated Marking and Reading Symbols

[2]U S Department of Defense, *Laser Etched Weapons Test Final Report*, June 1984 (revised August 1985)

[3]Headquarters, U S Marine Corps, *Logistics Applications of Automated Marking and Reading Symbols (LOGMARS) Marine Corps Application Demonstration in Weapons Control*, 30 June 1986

small arms inventory and accounting systems. The Air Force and the Army have both chosen laser etching as the only suitable method of applying bar codes to small arms because of its superior durability and resistance to unauthorized alteration.

In response to these concerns, the Logistics Management Institute (LMI) was tasked in March 1986 to recommend the most suitable means for marking both fielded and unfielded small arms for all the Services. Specifically, LMI was tasked to:

- Identify the data elements to be bar coded on the weapons
- Identify alternative marking program options and develop strategies on where and how the marking should take place
- Conduct a cost/benefit analysis of each alternative and recommend the preferred one
- Identify the types of installations and activities at which a marking capability is necessary or desirable
- Recommend, by Military Service, which inventory categories of weapons should and should not be marked
- Identify other items that are candidates for bar coding.

Because of the imminent fielding of the M9 pistol, two studies were requested. The first study, completed in July 1986, considered the issue of marking as-yet-unfielded weapons (in particular the M9) for all Services[4]. That study recommended procedures for etching the M9 and specified a marking strategy for future weapons procurements. The second study, for which this is the final report, recommends procedures for marking the inventory of the M16 family of rifles and deals with the longer-term issue of marking previously fielded weapons.

ASSUMPTIONS

While we realize that any fielded inventory system will be utilized for many types of weapons, we have restricted our analyses to the M16 family of rifles. The M16 is by far the most numerous of all U.S. Military small arms, constituting over 50 percent of the entire inventory. The family includes three models, the M16, M16A1 and M16A2. The latest of these, the M16A2, is still in production more than

[4]Logistics Management Institute, *LOGMARS Small Arms-Marking for the 9mm Personal Defense Weapon*, Report MC601R1, July 1986

20 years after the initial fielding of the original M16. It is the standard rifle for three of the four Services and, as such, is the standard weapon for a large majority of tactically deployed Service members worldwide. For this reason, the population of M16s is not only large, but broad; it is found in relatively large numbers in nearly all unit arms rooms. Because of these qualities, measuring the cost effectiveness of laser etching M16s can serve as a baseline to which other weapon types may be compared.

One problem noted by the Marine Corps in its development of bar coding for small arms tracking and inventory control was the need to precisely identify the data elements to be encoded on each type of weapon. The Services are considering the option of adding a "weapon type" code to eliminate the remote possibility of confusing two different types of weapons that happen to have the same serial number.

We believe it is far more important that all Services agree to etch the same data than to select any particular set of data elements. Interservice transfer of large quantities of weapons is common, and the use of different marking schemes among Services would cause serious incompatability problems in accounting for the transferred weapons. For purposes of this study, we assume that the Services will adopt the "serial number only" recommendation of the earlier LMI study.

In that study of the M9, we found very few commercial facilities suitable for etching weapons and those that we did identify were extremely expensive compared to the cost of in-house operations. (A large portion of this commercial cost involves the need to build secure storage facilities at the contractor's etching site. The contractors we investigated do not have storage facilities that meet the current strict small arms security regulations.) We assume that this situation has not changed significantly in the few months since that report and that the dearth of commercial facilities capable of executing a large-scale weapon etching program in a timely and cost effective manner still exists.

Because of the negative impact that etching of fielded weapons would have on unit readiness, the high administrative overhead, and the extremely high costs of secure transportation, we believe that where possible, weapons should be marked before they are issued to units in the field; we assume that this will be the case.

We assume that the technical findings of the DoD Laser-Etched Weapons Test[5] regarding etching times, etcher capacities, etcher service life, and operating costs are valid. Using that report, we have projected that:

- The capacity of current laser-etching units equipped with material handling attachments is 758 M16 rifles per 8-hour day
- In-house etcher operations would require two personnel at a total cost of $4,467 per month (based on a labor rate of $12.69 per hour and approximately 173 work hours per person per month)
- The service life of a laser etcher is approximately eight years.
- Maintenance of a laser-etcher requires an average of 20.8 work hours per year at a labor rate of $15.61 per hour. The average monthly cost of maintenance is $27.

During the course of the study, we discovered that each Service has fielded, or is in the process of fielding, a computer system suitable for supporting a bar code-based weapons inventory system. Since those computer systems are already funded by independent sources for other reasons, we have not included any of their procurement or development costs in our cost analyses, except where additional hardware is required solely to support the weapons inventory application. Examples of such additional hardware include the purchase of more bar code scanners where necessary and the cost of several personal computer-based systems being purchased by the Marine Corps solely for use in a weapons inventory system at selected armories.

Our costs are based on the assumption that no uncosted troop labor will be used in the etching program, except to bring weapons to an etcher location within 35 miles of the installation. However, cost savings may be realized in improving the efficiency of operations currently performed by troops. Other assumptions are that an etching program must not significantly impair readiness, that repackaging costs must be considered when weapons are shipped, and that Service-procured laser etchers will be used to full capacity for other applications even though weapon etching will represent only a portion of the total throughput.

[5]Department of Defense Report, op. cit.

We assume that the benefits to be realized by each Service in fielding a bar code-based inventory system for small arms are those identified in the Marine Corps application study.[6] That study, which utilized traditional time-and-motion techniques, identifies significant man-hour savings when weapons are inventoried using automated methods rather than traditional, manual techniques. We recognize, however, that the cost savings realized by each Service are dependent on factors unique to that Service, such as the frequency of inventories and the grade levels of inventorying personnel.

If the overall bar code inventory system is to be economically viable, the costs of performing the bar code etching must be identified and balanced against the savings to be realized by automating the inventory process. To determine the cost of laser etching M16s, we must first investigate the various strategies available for performing the etching.

[6]Headquarters, U.S. Marine Corps, op. cit.

CHAPTER 2

MARKING STRATEGIES

When awarded, the original contract for the M16 had no requirement for bar coding. As a result, the Services now maintain large inventories of uncoded weapons and are continuing to receive shipments of uncoded weapons from the manufacturer. We considered the following three options for etching weapons currently in the inventories and those yet to be delivered:

- Option 1: Modify the current acquisition contract to encode the weapons at the factory before they are shipped.
- Option 2: Purchase an etcher and use it to bar code the M16s and to etch other weapons or items at a central predetermined site.
- Option 3: Purchase an etcher, mount it on a truck, and move it to the sites of those inventories that are cost-effective to etch.

The options are not mutually exclusive; e.g., the Army (the lead Service for the M16A2 acquisition) might modify its contract to require the manufacturer to apply laser-etched bar codes on as-yet-undelivered weapons and the Services might then use some other means to bar code those weapons delivered prior to the modification. We compared the options on the basis of cost per weapon.

OPTION 1: MODIFY THE CURRENT CONTRACT

The first option is to modify the current acquisition contract for the M16A2 to require that bar codes be etched on the weapons during production. Since the terms of the contract specify that the weapons are purchased F.O.B. origin (with government shipment to the individual Services), they can be etched with minimal cost or delay before they are packed.

This option is the most attractive one from the cost standpoint because it eliminates the additional transportation and packing requirement inherent in the

other options. We estimate the cost to the manufacturer to be only about 50 cents per weapon.

The major disadvantage of this option is that it is only effective for weapons that have not yet been delivered. All M16 and M16A1 rifles have been fielded, and deliveries of M16A2 rifles are well underway. (In fact, Marine Corps fielding of the latter weapon is already over 50 percent complete.) However, since M16A2s are scheduled for delivery well into the 1990s, this option should be considered.

OPTION 2: PURCHASE A LASER-ETCHER: ETCH AT A CENTRAL SITE

Option 2 is to acquire a laser-etcher and install it at a central site. Weapons would be shipped to the facility by a using unit (or by the manufacturer), etched, then shipped back to the unit.

The primary advantage of this alternative is that the laser-etcher will be operated in a standard production environment, presumably at a pre-existing maintenance facility. One laser etcher would have a throughput capacity of 758 weapons per 8-hour workday, which is sufficient to handle a large-scale M16 etching program and other tasks as well.

The main disadvantage of this option is that transportation and repackaging costs are extremely high. We estimate the cost of shipping weapons in a manner consistent with current security requirements to be between 2 cents and 7 cents per weapon per mile depending on the lot size. In addition, each rifle shipped from a using unit has to be packed twice for shipment (once at origin and once at the central site) at an estimated cost of $1.50 each time. For example, the cost of etching a single rifle located at a Marine armory in Norfolk, VA, at an etcher located at Marine Corps Logistics Base (MCLB) Albany, GA, would be in excess of $31 even before the cost of the etching. This option also requires that "float" weapons be supplied to users while the user's weapons are being etched in order to maintain readiness. While it is possible to permanently exchange marked weapons for unmarked ones, a large number of weapons will have to be committed to the "float," and those weapons will not be available for other tasks. Such an exchange will also impose the additional administrative burden of exchanging ownership of the weapons.

OPTION 3: UTILIZE A MOBILE ETCHER

We considered an option under which an etcher would be purchased, mounted on a truck, and then moved to armories. Although none of the vendors of laser etching equipment we contacted could give an example of such an installation, they were in agreement that a mobile etcher was technically feasible and practical. This option has the advantage of eliminating the transportation and packaging costs of moving weapons over long distances. Given the extremely large inventories of weapons in some restricted geographical areas, the cost of moving the etcher to the weapons would be much lower than the cost of moving the weapons to the etcher.

The disadvantages of this option are the high fixed and variable costs of operation, including the pay and per diem costs for the operators who accompany the etcher, the transportation and site installation of the laser etcher, and the miscellaneous overhead incurred in conducting an industrial-type operation in a traveling environment (see Table 2-1.) We estimate the personnel cost per operator per day while the etcher is on the road to be approximately $176 (as opposed to $106 per day in a static location). We estimate the vehicle cost to be approximately $1.00 per mile and the cost of other overhead (such as administration and utilities) to approximate the $135 per day charged at the Anniston Army Depot. We also estimate that each stop will require two nonproductive days for installation of equipment, maintenance, coordination, and other housekeeping functions. Finally, for amortization purposes, we estimate that in the mobile mission, one-third of the laser etcher's useful life will be lost because of the inevitable rough handling it will receive and the substantial periods of nonproductive time that will be incurred in travel. In total, each site visit will cost more than $970 in fixed overhead, not including transportation, before etching can even begin. The cost effectiveness of this option obviously depends on the operators etching a large volume of weapons at each site so that this fixed cost is spread over as many weapons as possible.

The selection of a strategy depends on the unique circumstances of the inventory being etched and on the unique inventory policies and procedures of each Service. Thus, we discuss our analysis and recommendations for each of the Services independently in the succeeding chapters.

TABLE 2-1

SOME COST FACTORS OF MOBILE ETCHER

Fixed Costs Per Site	Cost ($)	Variable Costs Per Site	Cost ($)
Operators (setup)	704	Transportation of Etcher	1.00/mile
Miscellaneous Overhead	270	Operators	176.00/day
		Amortization	0.40/weapon
		Overhead	270.00/day
Total	974		

CHAPTER 3

U.S. ARMY

Currently, the Army has approximately 1.4 million M16A1 rifles in its inventory. Approximately 1.32 million of the rifles are ready to use and are stored locally in unit arms rooms, while the remainder are packaged and stored at depot storage facilities for new issue, operational projects, or theater reserve. The Army has begun a program to replace M16A1 rifles with the improved M16A2 over the next 5 years. Deliveries from the contractor will reach 10,000 per month by April 1987 and will continue at approximately that rate for the life of the contract. After the delivery of the initial 550,000 rifles, another contract will be awarded for the remaining requirement. In addition, the Army will begin a depot conversion program at Anniston Army Depot (AAD) in April 1988 to convert M16A1 rifles to the M16A2 version at a rate of 15,000 per year.

The new M16A2 rifles will be issued in Department of the Army Master Priority List sequence, and will be fielded under the Total Package Fielding (TPF) concept. Under that concept, collateral items such as slings and magazines are packed with the rifle so that it is complete and ready to use upon receipt. To facilitate TPF, all rifles are being shipped from the manufacturer to AAD for packing.

INVENTORY PROCEDURES

At the unit level rifles are stored in arms rooms, generally at battalion or company level. In such cases, approximately 100 to 500 M16 rifles are stored in an arms room. A few training centers and brigade arms rooms, however, may store as many as 5,000 rifles (see Appendix A).

Army Regulation AR 710-2 requires that all small arms be inventoried monthly by serial number. While the regulation requires an impartial commissioned, noncommissioned, or warrant officer to perform the inventory, inventories are most commonly conducted by commissioned officers in the grade of

lieutenant (0-1 or 0-2). The officer individually compares the serial numbers on the rifles with a local serial number list. The Marine Corps application study demonstrated that inventorying weapons with laser-etched bar codes results in substantial savings. Table 3-1 shows the cost savings that the Army can realize by using bar code technology rather than the current manual method; the costs are based on use of a Second Lieutenant (0-1) as the inventory officer.

A semiannual inventory is required by the U.S. Army Armament Munitions and Chemical Command (AMCCOM)'s inventory control point at Rock Island Arsenal in accordance with the DoD small arms serialization program requirement. That inventory is an Army-wide accounting of weapons by end user and location. It is conducted in the same manner as the routine monthly inventory, but the serial number listings that are utilized are generated by AMCCOM and the results are reconciled there.

Army installations and most units have automated property accounting systems, many of which have bar code interfaces. Those local systems accommodate small arms serial numbers and are the source of the monthly inventory lists. Currently, the lists are generated, the inventory is completed, and the results are manually entered into the property accounting system. Current bar code readers have the capability of entering those data automatically. Unit level computer systems—the Unit Level Computer (ULC) and the Tactical Army Combat Service Support (TACSS) computer systems—will be fielded in the near future. Those systems are designed for use with bar code readers and can easily be adapted to accept automated weapons inventory input. However, the addition of this capability to currently envisioned system functions may well increase the requirement for bar code readers. This is addressed in the cost analysis shown in Table 3-2.

TABLE 3-1

ESTIMATED U.S. ARMY

(Bar Code Cost Savings per 1,000 Rifles)

Current Inventory Time		48 06 hours
Bar Code Inventory Time		2 78 hours
Man-Hour Cost (0-1 Under 2 Years)		$6 95 hour
Present Inventory Costs Per Year	$4,007 88	
Bar Code Inventory Cost Per Year	2 31 72	
Annual Man-Hour Cost Savings	$3,776 16	

TABLE 3-2

COST/BENEFIT ANALYSIS: U.S. ARMY

(For 1.32 Million M16 Rifles[a])

	Cost Per 1,000 Weapons ($)	Total Costs ($)
Program costs:		
Etching	$ 587 10 (Table 3-3)	775,000
Additonal bar code readers	$ 3,000 00 (@ $1500 each)	3,960,000
Total	3,587 10	4,735,000
Program benefits:		
Present inventory cost	4,007 88	5,291,000
Less bar code inventory cost	(231 72)	(306,000)
Total	3,776 16	4,985,000
Payback Period for Program	0 95 years	

[a] Effects of scheduling are not included here

MARKING STRATEGY

Near-Term Recommendation

The most cost-effective, near-term marking strategy for the Army is to use a central etcher placed at AAD. We recommend that strategy. Since all Army M16A2s will be shipped from the manufacturer to AAD for TPF and because AAD is converting M16A1s to M16A2s, it is an ideal point for marking both categories of M16A2s prior to issue.

While marking newly-manufactured M16A2s rifles at the factory is approximately 15 percent less costly on a per-weapon basis than marking them at AAD (see Table 3-3), we believe that such a strategy is not the most cost-effective one at the present time. When the weapons undergo periodic depot maintenance, the process of restoring their surface coating obliterates the etched bar code. Thus, to maintain the number of etched weapons in the field, it will still be necessary to install an etcher at AAD to re-etch the weapons before they are returned for use. Furthermore, if the rifles are etched only at the factory, the converted M16A1 rifles will not be etched. Thus, a program of factory etching would be less cost-effective over time than would the strategy we have recommended.

The 5-year duration of the current M16A2 acquisition contract will provide more than enough time to recoup the cost of the etcher as shown in Table 3-2. However, the analysis is oversimplified since the duration of the etching program will be longer than the payback period.

Long-Term Recommendation

In the long term, factory etching is the best marking strategy for the Army. While maintaining an etching capability at the depot is a continuing requirement, the addition of other weapons to the laser etching program will put a strain on the ability of one etcher to keep up with the workload. Rather than procure additional etchers, it will be much more cost-effective to reduce the load on present resources by requiring all newly delivered small arms to be coded at the factory. We recommend that future small arms procurements include the bar coding requirement as an integral part of the equipment specifications.

TABLE 3-3

MONTHLY LASER ETCHING COSTS

	Purchase Etcher; Etch At AAD	Contract For Etching At Manufacturer
Amortization ($150,000 @ 8 Years)	$1,563	$1,563
Operators ($12.89/hr x 2)	4,467	4,467
Maintenance	27	27
Overhead	2,981[a]	726[b]
Profit	0	980[b]
Total Monthly Cost	$9,038	$7,763
Maximum weapons etched per month	15,395	15,395
Cost per weapon	$0.587	$0.50

[a] Current overhead rate at AAD.

[b] Overhead and profit are estimated based on historical experience

CHAPTER 4

U.S. NAVY

The M16 rifle is used only in limited numbers in the Navy; its issue is restricted primarily to Construction Battalion (SEABEE) units. (The M14 rifle is standard for other uses.) Nearly all of the Navy's M16 inventory is crated for use in support of its mobility mission, either at the location of active SEABEE units at Gulfport, MS, and Port Hueneme, CA, or in central storage at the Naval Weapons Center, Crane, IN. Since these weapons are inventoried only through use of the serial numbers marked on the crates, the Navy has little need to read individual weapon serial numbers automatically. Thus, the Navy has chosen not to participate in this study.

CHAPTER 5

U.S. AIR FORCE

The U.S. Air Force, including the Air Force Reserve and the Air National Guard, has approximately 250,000 M16 rifles. Of these, 214,000 are located in the continental United States (13,400 of those are war reserve materiel); 31,500 are in Europe; 6,700 in the Pacific; and 1,750 in Alaska (see Appendix A). The Air Force still uses the standard M16 rifle and, unlike the Army and the Marine Corps, is not planning to purchase the M16A1 or M16A2.

Air Force weapons inventories are divided into two functional categories: active and crated. Active weapons are generally used for the day-to-day physical security of installations, while crated weapons are set aside for issue to deploying units to support air base ground defense. The proportions of active to crated weapons in general and M16 rifles in particular vary among installations. Since installations within each Major Command generally have a similar ratio of active to crated weapons, Major Command averages were used in our analysis of installation etching costs and benefits.

INVENTORY PROCEDURES

All Air Force weapons are inventoried semiannually in compliance with Air Force Manual (AFM) 67-1. This inventory, jointly conducted by personnel from the Base Supply activity and the owning activity, accounts for each weapon individually by serial number. Inventory results are forwarded to Warner Robins Air Force Base (AFB) for an Air Force-wide reconciliation of weapons inventory records with respect to using activity and location.

Crated weapons are generally stored in weapons bunkers. Although the Air Force has recently attempted to unpack and assign individual weapons to deployment team members, particularly to the Air National Guard, armory space limitations have precluded widespread implementation of that policy. Crated weapons are inventoried using a 3 percent individual random sample. The sampled weapons are uncrated, and their serial numbers are compared with the serial numbers listed on the exterior of the crate and with the master inventory listing. If

all serial numbers match, the unsampled weapons are inventoried by crate markings only. However, if a serial number in the sample does not match, all weapons in the storage area are uncrated and individually inventoried.

Active weapons are stored in racks in a central armory at each installation under the control of the local Air Force Security Police. As in the case of crated weapons, AFM 67-1 requires a semiannual serial-number inventory, which is jointly conducted by Base Supply and Security Police representatives. (Grade levels of those conducting the inventories are typically from E4 to E7.)

In addition to the semiannual inventory, local Security Police regulations often require additional, more-frequent serial number inventories for active weapons. The practice at any given installation depends on the specific policy of the installation's governing Major Command, and those policies differ dramatically among Major Commands. The Military Airlift Command (MAC), for example, requires a weekly serial number inventory at its installations, while most other Major Commands are satisfied with semiannual inventories. The inventory policies can be found in Major Commands supplements to Air Force Regulation (AFR) 127-37, paragraph 7-13c.

AUTOMATION RESOURCES

The Air Force is currently fielding the Security Police Automated System (SPAS), a microcomputer-based system designed to aid in a number of administrative tasks within Security Police units. SPAS is to be fielded at 372 of the Air Force's 455 Security Police units. Weapons inventory functions are included in SPAS, and the system has the capability of using bar code readers for data entry. Bar code readers are included as an unfunded requirement for the FY91 SPAS program, but the type of reader to be purchased (portable or hard-wired) has not been determined.

Purchase of 216 readers is currently planned under the SPAS program; that would not be enough readers to meet the additional requirements of a bar code-based armory control system at each installation. For this reason, we have included the purchase of additional readers in our cost analysis. Our basis for issue is one reader per armory for units with up to 500 weapons and one reader per 500 weapons for larger armories.

RECOMMENDED MARKING STRATEGY

We recommend that crated Air Force M16 rifles not be marked. The Air Force indicated that the expense of conducting a serial-number inventory of 100 percent of crated weapons is considerable when the 3 percent random check produces errors; while bar coded serial numbers would substantially reduce that expense, the 100 percent inventories occur very infrequently (we were unable to obtain figures that demonstrated regular occurrence of such inventories), and the cost of crating, marking, and recrating the weapons is very high. We do not recommend marking crated weapons.

We used a mathematical model (see Appendix B) to examine two basic strategies for marking active M16 rifles: transporting the weapons to a centrally located etcher and transporting an etcher to the various armories. In the model, we estimated the cost involved in either moving an etcher to any given site or transporting weapons to a central etcher currently located at the Air Force small arms depot at Hill AFB, UT. Because the inventory policy varies from installation to installation, we examined the possibility of etching weapons at installations with as few as 72 active M16s. In addition to the two "pure" strategies, we also examined several program alternatives which combine the two.

As a result, we found that the most cost-effective program for the Air Force is a combined mobile and central-site etcher program conducted jointly with the Marine Corps. The proposed routine for a mobile etcher program along with the associated costs and benefits are detailed in Appendix C. Because active Air Force M16s tend to be in low density in geographically spread areas, we found that it is cost-effective to etch M16 rifles at only 19 Air Force installations. In the combined Air Force Marine Corps program, we found that at one site (Edwards AFB, CA), it was more cost effective to have weapons etched at the small arms repair facility at Hill AFB. The overall cost of the program to the Air Force will be approximately $60,000, with a pay-back period of approximately 6 months based on savings from the reduced requirement for military inventory manpower. The time to complete the overall program will be approximately 8 months based on full utilization of etcher capacity less transportation and setup time.

We also calculated the costs of centrally etching all the weapons, as well as the cost of an "Air Force-only" etching program. The comparison of these costs is given in Table 5-1.

TABLE 5-1

COMPARISON OF ETCHING PROGRAM ALTERNATIVES

(United States Air Force)

Type of Program	USAF Cost ($)	USAF Benefits ($)	Pay Back Period
USAF/USMC program[a]	60,008	133,955	0.45 year
USAF-only program[a]	65,840	133,895	0.49 year
Central etch only[b]	89,852	133,955	0.67 year

[a] Includes mobile etcher and central etching at Hill AFB, UT, where cost-effective

[b] Central etching at Hill AFB, UT

CHAPTER 6

U.S. MARINE CORPS

The Marine Corps maintains an inventory of approximately 233,000 M16 family rifles. Of that number, 60,000 are located in war reserve or other permanent storage accounts. Another 34,000 are located overseas, with a majority in Okinawa (19,000). The balance of the inventory is in the continental United States in the four different classifications of armories listed below. While the weapon density figures given refer to all types of weapons, M16 type rifles represent the bulk of the inventory.

The Marine Corps classifies its armories into the following four types:

1. *Type 1* consists of those armories associated with Inspector and Instructor Staffs, Marine Barracks, and Detachments. They contain up to 1,000 weapons.

2. *Type 2* armories contain the consolidated arms inventories of battalions and/or squadrons. They contain from 1,001 to 3,000 weapons.

3. *Type 3* armories are found at infantry training schools. They contain a wide variety of weapons, numbering from 3,001 to 7,000.

4. *Type 4* armories are extremely high density facilities found at the Recruit Depots at Parris Island, NC, and San Diego, CA. They contain in excess of 7,000 weapons each.

While Marine Corps installations are located throughout the country, 87 percent of the M16 rifles in the continental United States are located at 18 areas (see Appendix A). Of these, the area surrounding Camp Pendleton, CA, is by far the largest, containing more than 35,000 rifles.

The Marine Corps was the first Service to take deliveries of the M16A2. Its current plans call for the rapid replacement of all the earlier model M16s in the inventory with this improved weapon. As of the present time, planned shipments of the M16A2 to the Marine Corps are well over 50 percent completed. Unlike those to the Army, shipments of M16A2s to the Marine Corps are being made directly from the factory to the units in the field and are not centrally received for packaging with

their ancillary equipment. Thus, it is impractical to etch these weapons enroute from the manufacturer.

INVENTORY PROCEDURES

The 60,000 weapons in permanent storage accounts are crated and are inventoried by comparing the serial numbers marked on the crates with a master inventory list. If the seals on the crates are undisturbed, the weapons are considered to be properly accounted for. Thus, the weapons in this category are seldom, if ever, inventoried individually. For this reason, there is no appreciable benefit to be gained by etching them, and we recommend that they not be etched while in storage.

The balance of the Marine Corps rifles are located in active (i.e., rack storage) armories. (That balance also includes a substantial number of weapons maintained aboard ships by Marine units afloat.) Those weapons are inventoried monthly by serial number by a junior officer or mid- to senior-grade noncommissioned officer in accordance with Marine Corps Order MCO 8300.1C.

Current plans call for the purchase of microcomputer-based systems to assist in the inventory and accounting of *Types 3* and *4* armories. Limited purchases of other bar code equipment are also planned to support the automation of the inventory process at smaller armories. We have included the cost of all this equipment in our analysis.

MARKING STRATEGIES

We analysed two basic strategies for marking active Marine M16s: transporting the weapons to a centrally located etcher for marking, and transporting an etcher to the various armories. The Marine Corps weapons lend themselves naturally to the second strategy because of the large concentrations of weapons in relatively small but geographically dispersed sites. We also examined several program alternatives comprised of a combination of these two strategies.

In order to determine the most cost-effective manner in which to mark the weapons, we used a mathematical model to compare various alternatives (see Appendix B). As a part of the process, we estimated that the lowest fixed cost incurred in either moving an etcher to a given site or transporting weapons to a central etcher location would be equivalent to the inventory savings accrued for a bar coded inventory of approximately 500 weapons. Therefore, we investigated only

those central sites whose inventories both totaled 500 or more weapons, and were located within 35 miles of the central site. The cutoff point for the Air Force was considerably different because of its radically different inventory policies.

We found that the most cost-effective program for the Marine Corps is a combined mobile etcher program conducted with the Air Force, and we recommend that strategy. The costs and benefits are detailed in Appendix C. We found that in no case is it cost-effective to etch any Marine Corps weapons at a central site because of the concentration of weapons. Overall cost of the program to the Marine Corps would be approximately $435,000, and the pay-back period of the investment would be approximately 1 year based on the reduced requirement for military inventory manpower. The time to complete the overall program would be approximately 8 months based on full utilization of etcher capacity less transportation and setup time.

We also calculated the costs of centrally etching all the Marine Corps active weapons and the cost of a "Marine-only" mobile etching program. Those costs are compared in Table 6-1. The reduced transportation costs for the combined Air Force/Marine Corps program result in etching at additional sites becoming cost-effective at very little increase in cost. In the USMC-only program, the greater net transportation costs for the mobile etcher results in rifles at some sites being etched at a lower cost at a central etching facility at the Marine Corps small arms depot in Albany, GA.

TABLE 6-1

COMPARISON OF ETCHING PROGRAM ALTERNATIVES

(United States Marine Corps)

Type of Program	USMC Cost ($)	USMC Benefits ($)	Pay Back Period
USAF/USMC combined[a]	434,821	439,855	0 99 year
USMC-only mobile[b]	432,386	437,209	0 99 year
Central etching only	683,177	439,855	1 55 year

[a] For some Air Force weapons. Includes central etching at Hill AFB, UT, where cost-effective

[b] Includes central etching at MCLB Albany, GA, and Hill AFB, UT where cost-effective

CHAPTER 7

RECOMMENDATIONS

We recommend the following strategies for laser etching M16 rifles:

ARMY

Army M16A2 rifles should be centrally marked at Anniston Army Depot. Rifles delivered from the current M16A2 production contract and those from the M16A1-to-M16A2 rifle conversion program should be etched at AAD to minimize the costs of packaging and transportation that would be necessary under other options. Since the M16A2 will replace the active inventory of other M16 rifles in the Army, we recommend against marking currently fielded M16s rifles.

NAVY

The Navy does not intend to use bar codes in its small arms inventory process. Since the Navy has chosen not to participate in this study, we were unable to obtain the information necessary to evaluate cost-benefit tradeoffs or to recommend a marking strategy.

AIR FORCE

The Air Force should mark only active (uncrated) M16s at the installations listed in Appendix C. Active rifles from Edwards AFB should be etched at Hill AFB, where an etcher is already available. The other M16 inventories in Appendix C should be etched with a mobile etcher in conjunction with the Marine Corps.

MARINE CORPS

Marine Corps active M16 rifles should be etched with a mobile etcher that would be transported to the Marine Corps and Air Force installations listed in Appendix C.

GENERAL RECOMMENDATIONS

We recommend that only the weapon serial number be bar coded. Service representatives have indicated an interest in adding a weapon identifier code to the serial number bar code. We concur only if a common code can be identified and if all small arms that are marked are marked in the same format. A formal specification should be developed and adopted by all Services before marking any M16 rifles. The M16A2 rifle and the M9 pistol delivery schedules necessitate quick action in this matter.

We also recommend that all future small arms acquisitions include a requirement for laser-etched bar codes. Factory etching offers the potential of the lowest-cost bar codes on new weapons. Since labor savings for weapons inventories are substantial, the added cost of bar coding will be quickly offset.

APPENDIX A

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES (U.S. ARMY, U.S. AIR FORCE, AND U.S. MARINE CORPS)

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES
U.S. ARMY, U.S. AIR FORCE, U S MARINE CORPS

(Includes all reported weapons within a 35-mile radius)

Service	Location	State	Weapons
Army	Aberdeen PG	MD	1 383
Army	Dover	NJ	532
Army	FT Belvoir	VA	3 956
Army	FT Benning	GA	25 41
Army	FT Bliss	TX	11 289
Army	FT Bragg	NC	45 167
Army	FT Campbell	KY	23 215
Army	FT Carson	CO	23 472
Army	FT Devens	MA	13 719
Army	FT Dix	NJ	25 21
Army	FT Drum	NY	10,780
Army	FT Eustis	VA	4,799
Army	FT Gillem	GA	5,507
Army	FT Gordon	GA	1,823
Army	FT Harrison	IN	3 535
Army	FT Hood	TX	37 525
Army	FT Huachuca	AZ	2 971
Army	FT Irwin	CA	1 745
Army	FT Jackson	SC	18,593
Army	FT Knox	KY	16,186
Army	FT Lee	VA	5,780
Army	FT Leonard Wood	MO	20,956
Army	FT Lewis	WA	27,462
Army	FT McClellan	AL	10,765
Army	FT McCoy	WI	15,691
Army	FT Ord	CA	19,843

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES
U.S. ARMY, U.S. AIR FORCE, U.S. MARINE CORPS

(Includes all reported weapons within a 35-mile radius)

Service	Location	State	Weapons
Army	FT Polk	LA	13,651
Army	FT Riley	KS	19,707
Army	FT Rucker	AL	4,717
Army	FT Sam Houston	TX	11,625
Army	FT Sheridan	IL	24,360
Army	FT Stewart	GA	24,515
Army	Presidio San Fran	CA	6,241
Army	Redstone Arsenal	AL	987
Army	Seneca Army Depot	NY	603
Army	USMA West Point	NY	3,187
Air Force	Andrews AFB	MD	2,512
Air Force	Baltimore	MD	1,164
Air Force	Barksdale AFB	LA	1,804
Air Force	Bergstrom AFB	TX	2,720
Air Force	Birmingham AP	AL	1,078
Air Force	Blytheville AFB	AR	531
Air Force	Boise AP	ID	859
Air Force	Bradley ANGB	CT	996
Air Force	Burlington	VT	739
Air Force	Byrd Field	VA	731
Air Force	Cannon AFB	NM	2,110
Air Force	Carswell AFB	TX	2,409
Air Force	Castle AFB	CA	682
Air Force	Charleston AFB	SC	1,338
Air Force	Charlotte ANGB	NC	702
Air Force	Davis Monthan AFB	AZ	2,507

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES
U.S. ARMY, U.S. AIR FORCE, U.S. MARINE CORPS

(Includes all reported weapons within a 35-mile radius)

Service	Location	State	Weapons
Air Force	Des Moines MAP	IA	921
Air Force	Dobbins AFB	GA	1,976
Air Force	Dover AFB	DE	983
Air Force	Duluth	MN	816
Air Force	Dyess AFB	TX	1,939
Air Force	Edwards AFB	CA	754
Air Force	Eglin AFB	FL	6,171
Air Force	Ellsworth AFB	SD	1,476
Air Force	England AFB	LA	2,242
Air Force	Fairchild AFB	WA	2,060
Air Force	FT Smith MAP	AR	738
Air Froce	Francis E. Warren AFB	WY	1,829
Air Force	FT Wayne MAP	IN	781
Air Force	Garden City	GA	1,070
Air Force	George AFB	CA	2,282
Air Force	Grand Forks AFB	ND	1,446
Air Force	Griffiss AFB	NY	661
Air Force	Grissom AFB	IN	1,104
Air Force	Hanscom AFB	MA	616
Air Force	Hill AFB	UT	3,512
Air Force	Holloman AFB	NM	3,117
Air Force	Homestead AFB	FL	2,700
Air Force	Hulman Field	IN	772
Air Force	Jackson	MS	804
Air Force	Jacksonville NAS	FL	593
Air Force	KI Sawyer AFB	MI	738

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES
U.S. ARMY, U.S. AIR FORCE, U.S. MARINE CORPS

(Includes all reported weapons within a 35-mile radius)

Service	Location	State	Weapons
Air Force	Kellogg APRT	MI	633
Air Force	Kelly/Lackland AFB	TX	5,533
Air Force	Kingstown	RI	768
Air Force	Kirtland AFB	NM	2,227
Air Force	Langley AFB	VA	3,360
Air Force	Lincoln MAP	NE	866
Air Force	Little Rock AFB	AR	2,443
Air Force	Loring AFB	ME	739
Air Force	Louisville	KY	842
Air Force	Lowry AFB	CO	1,684
Air Force	Luke AFB	AZ	1,924
Air Force	Macdill AFB	FL	1,600
Air Force	Madison	WI	711
Air Force	Malstrom AFB	MT	1,334
Air Force	Mansfield MAP	OH	523
Air Force	Martinsburg	WV	515
Air Force	Maxwell AFB	AL	2,188
Air Force	Mc Entire ANGB	SC	1,179
Air Force	McClellan/Mather AFB	CA	1,911
Air Force	McConnell AFB	KS	1,053
Air Force	McGuire AFB	NJ	2,105
Air Force	Memphis	TN	517
Air Force	Meridian	MS	1,003
Air Force	Middletown	PA	1,137
Air Force	Minneapolis/St Paul	MN	2,483
Air Force	Minot AFB	ND	1,398

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES
U.S. ARMY, U.S. AIR FORCE, U.S. MARINE CORPS

(Includes all reported weapons within a 35-mile radius)

Service	Location	State	Weapons
Air Force	Mitchell Field	WI	989
Air Force	Moffett FLD	CA	923
Air Force	Moody AFB	GA	2,357
Air Force	Mountain Home AFB	ID	2,052
Air Force	Myrtle Beach AFB	SC	2,371
Air Force	Nanaimo	BC	1,488
Air Force	Nashville	TN	908
Air Force	Nellis AFB	NV	3,868
Air Force	New Orleans	LA	1,474
Air Force	Niagara IAP	NY	681
Air Force	Norton/March AFB	CA	4,161
Air Force	Offutt AFB	NE	830
Air Force	O'Hare APRT	IL	1,048
Air Force	Pease AFB	NH	913
Air Force	Peoria APT	IL	804
Air Force	Peterson AFB	CO	1,878
Air Force	Pittsburgh IAP	PA	1,452
Air Force	Plattsburg	NY	721
Air Force	Pope AFB	NC	2,117
Air Force	Portland IAP	OR	1,406
Air Force	Reno MAP	NV	788
Air Force	Rickenbacker ANGB	OH	1,833
Air Force	Schenectady AP	NY	585
Air Force	Scott AFB	IL	1,921
Air Force	Selfridge ANGB	MI	1,658
Air Force	Seymour Johnson AFB	NC	2,448

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES
U.S. ARMY, U.S. AIR FORCE, U.S. MARINE CORPS

(Includes all reported weapons within a 35-mile radius)

Service	Location	State	Weapons
Air Force	Shaw AFB	SC	3,655
Air Force	Sioux City ANGB	IA	769
Air Force	Sioux Falls	SD	637
Air Force	Springfield APRT	IL	821
Air Force	Syracuse	NY	1,094
Air Force	Tinker AFB	OK	3,263
Air Force	Toledo Express AP	OH	922
Air Force	Travis AFB	CA	1,578
Air Force	Tulsa	OK	630
Air Force	Vandenberg AFB	CA	1,067
Air Force	Warner Robins AFB	GA	1,398
Air Force	Westover AFB	MA	1,187
Air Force	Whiteman AFB	MO	1,098
Air Force	Willow Grove	PA	1,464
Air Force	Wright Patterson AFB	OH	2,227
Air Force	Wurtsmith AFB	MI	597
Air Force	Youngstown MAP	OH	658
Marine	Boston	MA	543
Marine	Camp Lejeune	NC	32,544
Marine	Camp Pendleton	CA	36,400
Marine	Charleston	SC	510
Marine	Chicago	IL	723
Marine	Dallas	TX	864
Marine	New Orleans	LA	646
Marine	New York City	NY	1,639
Marine	Norfolk	VA	2,806

MAJOR LOCATIONS OF M16 RIFLES IN THE CONTINENTAL UNITED STATES
U.S. ARMY, U.S. AIR FORCE, U.S. MARINE CORPS

(Includes all reported weapons within a 35-mile radius)

Service	Location	State	Weapons
Marine	Parris Island	SC	13,771
Marine	Philadelphia	PA	666
Marine	Quantico MCB	VA	9,802
Marine	San Diego MCB	CA	12,346
Marine	San Francisco	CA	1,327
Marine	Seattle	WA	585
Marine	Twentynine Palms MCB	CA	4,586
Marine	Yuma MCAS	AZ	1,231

APPENDIX B

SMALL ARMS LASER ETCHING MODEL (SALEM)

INTRODUCTION

The Small Arms Laser Etching Model (SALEM) is a computer-run mathematical model designed to aid a manager in deciding the most cost-effective way of laser-etching bar codes on dispersed small arms inventories. It is written in COMPAQ BASIC and is designed to run on any IBM Personal Computer (PC) or PC-compatible computer. The program listing is included at the end of this appendix.

The subject inventories are assumed to be in an estimated number of armories whose sizes are known and that are located at various geographically dispersed installations. The pay-back analysis is based on inventory manpower savings. Factors that affect this calculation, such as the frequency with which inventories are taken and the pay grades of inventorying personnel are assumed constant for the entire installation and are based on Service or Major Command policy.

SALEM begins by calculating the distances between all the sites on the installation data base which are coded for inclusion. Then, beginning with the installation maintaining the largest number of weapons, it performs a break-even analysis comparing both the cost of etching the weapons centrally at a predetermined location and the cost of moving a truck-mounted etcher to the installation; savings are gained through reduced inventory manpower. (Tables A-1 through A-3 present simplified explanations of these calculations.)

If it is more cost-effective to utilize the mobile etcher, the installation is designated for that use and the analysis is repeated for the "nearest" installation to the first, based on a calculation of the best routing. That process is repeated, with the model generating an ordered list of sites representing the proposed routing and etching sites of a mobile etching program. All sites previously found not to be cost-effective are repeatedly re-evaluated until SALEM finds that no further changes to the routing can be made. At that point, a report is generated, giving the proposed routing and designating those sites whose weapons can be etched more cheaply at the central site and those at which neither on-site nor central-site etching is cost-effective.

The attached listing represents the version of SALEM that was utilized to produce the Marine Corps and Air Force etching program recommendations. In order to be run, additional data files must be included, such as the distance table file

(named DIST.DAT in the program) and the installation data base files (called NAMES and BASLOC).

COST OF A CENTRAL ETCHING FACILITY

The cost of etching the weapons of one installation utilizing a designated central etching facility are given by:

$$C = xp + (ep*n) + (2*p*n) + [(n/tel)*cn] + cna + [(r/t)*n],$$

where

C = the cost of etching all weapons

xp = the cost of shipping, given the round-trip distance to the central etching site and a cost per mile for truckload and less-than-truckload lots

ep = amortization and overhead cost per weapon

n = the number of active weapons at the installation

p = cost to package one weapon for shipping

tel = basis of issue for purchase of additional bar code readers (varies by Service)

cn = cost of one bar code reader

cna = cost of additional hardware (varies by installation and Service)

r = personnel cost per day per fixed site

t = daily etching capacity of fixed laser etcher.

COST OF A MOBILE ETCHING PROGRAM

The cost of etching the weapons of one installation utilizing a mobile etcher are given by:

$$C = d*v + [(n/t) + do]*(ctdy + r) + ep*n + cn*(n/tel) + cna$$

where

d = (the distance from the last stop + the distance to the next stop) divided by 2

v = the cost per vehicle mile

do = days of overhead per stop

ctdy = cost of TDY per operator per day.

SAVINGS REALIZED WITH BAR CODE INVENTORY

The yearly savings realized at one installation by utilizing a bar code-based automated inventory system are given by:

S = (f1-f2)*(g*per*n),

where

S = the savings realized

f1 = the time required to inventory one weapon using manual techniques

f2 = the time required to inventory one weapon using a bar code-based automated system

g = the hourly manhour cost of inventory personnel (varies by Service)

per = number of inventories conducted per year.

SMALLL ARMS LASER ETCHING MODEL

(SALEM)

```
10 INPUT "HOW MANY INSTALLATIONS";LAST%

20 REM
30 REM  *** PARAMETER LIBRARY ***
40 REM
50 OPTION BASE 1 :REM Housekeeping; starts arrays at 1.
60 Y = 8 :REM years allowed to break even; also the laser amortization period.
70 CP = .288 :REM SAVINGS/WPN/MONTH FOR INVENTORY BY O-1 / O-2!
80 QOPT1 = 480 :REM Optimum quantity of wpns shipped; ie., 1 dromedary full.
90 QOPT2 = 240 :REM Optimum quantity of wpns shipped; ie., 1 dromedary full.
100 SOPT1 = .0236 :REM Shipping cost/weapon/mi for optimum ship qty (qopt).
110 SOPT2 = .0329 :REM Shipping cost/weapon/mi for optimum ship qty (qopt).
120 SODD = 6.580001E-02 :REM Shipping cost/weapon/mi for odd ship qty < qopt.
130 P = 1.5 :REM Cost of packaging 1 weapon.
140 V = 1! :REM Cost of vehicle per mile.
150 CTDY = 75! :REM TDY cost per person per day.
160 MD = 300 :REM Maximum miles per day to be travelled.
170 DO = 2 :REM Nonproductive days of overhead per stop.
180 T = 758 :REM Max thruput of laser in weapons/day.
190 R = 101.52 :REM Ordinary personnel cost per day (30 day month).
200 BUY = 150048! :REM Purchase price of laser.
210 F = 135.52 :REM Overhead rate per day.
220  CN = 1500  :REM Cost per scanner.
230 Q = 169  :REM Number of installations in file.
240 REM *** Variable Dictionary ***
250 REM  N1...STRING BLOCK # CONTAINING DESIRED DISTANCE
260 REM  I1...DISPLACEMENT OF DESIRED DISTANCE WITHIN BLOCK
270 REM  D8...DISTANCE TO CENTRAL ETCH SITE
280 REM  XP...COST OF TRANSPORT TO CENTRAL ETCH SITE
290 REM  W....NUMBER OF WEAPONS IN SYSTEM
300 REM  W9...PROPOSED NUMBER OF WEAPONS IN SYSTEM
310 REM  CCE..COST TO CENTRALLY ETCH
320 REM  C....COST TO ETCH WITH TRAVELLING ETCHER
330 REM  E....COST OF ETCHER PER WEAPON
340 REM  EP...PROPOSED COST OF ETCHER PER WEAPON
350 REM  BEP..BREAK-EVEN POINT
360 REM  L$().DATA BLOCKS IN DISTANCE BUFFER
370 REM  M$().HOLDING MATRIX FOR DATA BLOCKS FROM DISTANCE
    BUFFER
380 REM  DATA BLOCKS IN NAMES BUFFER-
390 REM   N1$..INSTALLATION NAME
400 REM   C$...COST TO ETCH
410 REM   S$...SAVINGS GAINED BY ETCHING
420 REM   N$...# OF WEAPONS
430 REM   D$...DAYS TO ETCH
440 REM   SV$..SERVICE CODE
450 REM   ST$..STATE CODE
460 REM  GO%()....CONTROL MATRIX
```

```
470 REM START%...CODE OF INSTALLATION TO BEGIN TRIP
480 REM A.....CODE OF CURRENT INSTALLATION BEING EXAMINED
490 REM B.....CODE OF CURRENT INSTALLATION BEING COMPARED TO
500 REM H.....LOWEST NET DISTANCE FOUND THUS FAR
510 REM H1.....CODE OF LOWEST NET DISTANCE-INSTALLATION #1
520 REM H2.....CODE OF LOWEST NET DISTANCE-INSTALLATION #2
530 REM H3.....CODE OF LOWEST NET DISTANCE-NEW INSTALLATION
540 REM D9.....LATEST CALCULATED NET DISTANCE
550 REM I,J.....COUNTERS
560 REM N.....NUMBER OF WPNS AT INSTALLATION (FROM N$)
570 REM LCE%.....LOCATION CODE OF CENTRAL ETCHER
580 REM D7.....ROUND-TRIP DISTANCE TO CENTRAL ETCHER
590 REM *** Housekeeping ***
600 CLS
610 LCE$ = ""
620 INPUT "WHAT IS BASE # TO LOCATE CENTRAL ETCHER";LCE%
630 IF LCE% < 1 OR LCE% > Q + 5 GOTO 620
640 DIM GO%(169),N$(12),CX(169),CY(169),L$(10), TDIST%(169),DIST%(169,85),
    CE(169),WPN%(169),PATHN(169),PATHS(169),SERV$(169),V9(9),RST(9),
    ANSWER(9)
650 DIM ST%(Q) :REM Initialize control matrices
660 REM Set minimum # of wpns to be etched
670 PBK = CP*Y*12
680 REM Select sites to investigate.
690  OPEN "R",#1,"F:NAMES",41
700 FIELD 1,25 AS N1$,4 AS C$,4 AS S$,2 AS N$,2 AS D$,2 AS SV$,2 AS ST$
710 FOR I = 1 TO Q
720   GET #1,I
730 REM Criteria to select installations; if selected,GO%(I) = 0.
740 GO%(I) = -8888
745 GOTO 810
750   IF SV$ = "AF" THEN GO%(I) = 0
760   IF SV$ = "AM" THEN GO%(I) = 0
770   IF SV$ = "AS" THEN GO%(I) = 0
780   IF SV$ = "AT" THEN GO%(I) = 0
790   IF SV$ = "AA" THEN GO%(I) = 0
800   IF SV$ = "AL" THEN GO%(I) = 0
810   IF SV$ = "MC" THEN GO%(I) = 0
820   IF GO%(I) = 0 THEN WPN%(I) = CVI(N$)
830   IF GO%(I) = 0 THEN SERV$(I) = SV$
840   NEXT I
850 CLOSE
860 OPEN "R",#1,"F:MAP",66
870 FIELD 1, 10 AS N$,4 AS X$,4 AS Y$,48 AS FILLER$
880 OPEN "I",#2,"F:BASLOC"
890 FOR I = 1 TO 169
900 INPUT #2,L9,R9
910 GET #1,L9
920 CX(I) = CVS(X$)
930 CY(I) = CVS(Y$)
940 NEXT I
950 CLOSE
960 OPEN "R",#1,"F:DIST.DAT",1621
```

```
970 FIELD 1,1 AS FLAG2$,162 AS L$(1),162 AS L$(2),162 AS L$(3),162 AS
    L$(4),162 AS L$(5),162 AS L$(6),162 AS L$(7),162 AS L$(8),162 AS L$(9),162
    AS L$(10)
980 FOR M = 1 TO 169
990 IF GO%(M)<0 THEN 1160
1000 PRINT "LOADING INSTALLATION #";M
1010 GET #1,M
1020 FOR J = 1 TO 169
1030 IF J = 163 THEN N1 = 3 ELSE N1 = J\82 + 1
1040 I1 = (J-1) MOD 81
1050 TDIST%(J) = CVI(MID$(L$(N1),(2*I1) + 1,2))
1060 NEXT J
1070 FOR I = 1 TO 169
1080 IF I > M THEN 1150
1090 IF I > 85 THEN 1120
1100 DIST%(M,I) = TDIST%(I)
1110 GOTO 1150
1120 YD = 170-I
1130 XD = 170-M
1140 DIST%(XD,YD) = TDIST%(I)
1150 NEXT I
1160 NEXT M
1170 CLOSE
1180 REM **** COMPUTE COST OF CENTRAL ETCH ********
1190 IF LCE% < > 170 THEN 1220
1200 LCE$ = "MCLB ALBANY"
1210 LCE% = 61
1220 IF LCE% < > 171 THEN 1250
1230 LCE$ = "ANNISTON DEPOT"
1240 LCE% = 143
1250 IF LCE% < > 172 THEN 1280
1260 LCE$ = "MCLB BARSTOW"
1270 LCE% = 73
1280 IF LCE% < > 173 THEN 1310
1290 LCE$ = "LETTERKENNEY DEPOT"
1300 LCE% = 89
1310 IF LCE% < > 174 THEN 1340
1320 LCE$ = "NWC CRANE"
1330 LCE% = 138
1340  OPEN "R",#1,"F:NAMES",41
1350 FIELD 1,25 AS N1$,4 AS C$,4 AS S$,2 AS N$,2 AS D$,2 AS SV$,2 AS ST$
1360 X1 = LCE%
1370 FOR I = 1 TO 169
1380 IF GO%(I)<0 THEN 1610
1390 GET #1,I
1400 X2 = I
1410 GOSUB 2410
1420 IF SERV$(I) = "AM" THEN WPN%(I) = INT(.27*WPN%(I))
1430 IF SERV$(I) = "AS" THEN WPN%(I) = INT(1!*WPN%(I))
1440 IF SERV$(I) = "AT" THEN WPN%(I) = INT(.14*WPN%(I))
1450 IF SERV$(I) = "AA" THEN WPN%(I) = INT(.3*WPN%(I))
1460 IF SERV$(I) = "AL" THEN WPN%(I) = INT(.35*WPN%(I))
1470 IF SERV$(I) = "AF" THEN WPN%(I) = INT(.53*WPN%(I))
1480 N = WPN%(I)
```

```
1490 D7 = 2*XD
1500 XP1 = (INT(N/QOPT1))
1510 IF XP1 < 0 THEN XP1 = 0
1520 XP2 = INT((N-(XP1*QOPT1))/QOPT2)
1530 IF XP2 < 0 THEN XP2 = 0
1540 XP3 = N-(XP1*QOPT1)-(XP2*QOPT2)
1550 XP = (XP1*QOPT1) + (XP2*QOPT2) + (XP3*SODD)
1560 HH = I
1570 GOSUB 5250
1580 EP = BUY/1477894!
1590 CCE = XP + (EP*N) + (2*P*N) + ((N/TEL)*CN) + ((R/T)*N)
1600 CE(I) = CCE
1610 NEXT I
1620 REM *** CONTROL MODULE ***
1630 GOTO 2550
1640 PRINT "WORKING....."
1650 W99 = -.1
1660 START% = 0
1670 FOR I = 1 TO 169
1680 IF GO%(I) < >0 THEN 1720
1690 IF WPN%(I) < W99 THEN 1720
1700 W99 = WPN%(I)
1710 START% = I
1720 NEXT I
1730 GO%(START%) = 1
1740 FOR I = 1 TO Q
1750 ST%(I) = 3333
1760 NEXT I
1770 LAST% = 1
1780 FOR I = 1 TO Q
1790 IF GO%(I) < >ST%(I) THEN GOTO 1830
1800 NEXT I
1810 GOSUB 2550
1820 END
1830 FOR I = 1 TO Q
1840 ST%(I) = GO%(I)
1850 IF GO%(I) = -9999 THEN GO%(I) = 0
1860 IF GO%(I) = -1111 THEN GO%(I) = 0
1870 NEXT I
1880 FOR J3 = 1 TO Q
1890 IF GO%(J3) = 0 GOTO 1920
1900 NEXT J3
1910 GOTO 1780
1920 H = 29999
1930 GOSUB 4390
1940 GOSUB 1960
1950 GOTO 1880
1960 REM *** CALCULATE VIABILITY SUBROUTINE ***
1970 N = WPN%(H3)
1980 IF GO%(H3) < >-1111 AND GO%(H3) < 1 THEN W9 = W + N
1990 EP = ((BUY/3)/W9) + (F/T)
2000 REM + + + FIGURE COST OF TRAVELLING ETCHER + + +
2010 HH = H3
2020 GOSUB 5250
```

```
2030 C=(D*V)+((N\T)+DO)*(CTDY+R)+(EP*N)+(CN*(N/TEL))+CNA
2040 REM  + + + FIGURE BREAK-EVEN POINT + + +
2050 BEP=Y*12*CP*N*FI
2060 REM  + + + NEITHER METHOD IS COST EFFECTIVE + + +
2070 IF CE(H3)<BEP OR C<BEP THEN GOTO 2110
2080 GO%(H3)=-9999
2090 GOTO 2400
2100 REM  + + + CENTRAL ETCH IS MOST COST EFFECTIVE + + +
2110 IF C<CE(H3) THEN GOTO 2160
2120 IF GO%(H3)=-1111 THEN GOTO 2400
2130 GO%(H3)=-1111
2140 W=W9:REM !!! REMOVE THIS LINE IF ROAD SHOW ETCHER < >
     CENTRAL ETCHER !!!
2150 GOTO 2400
2160 REM  + + + ROAD SHOW IS MOST COST EFFECTIVE + + +
2170 W=W9
2180 GO%(H3)=LAST%
2190  IF ABS(GO%(H1)-GO%(H2))<2 THEN 2230
2200  IF (GO%(H1)< >1 OR GO%(H2)< >LAST%) AND (GO%(H2)< >1 OR
     GO%(H1)< >LAST%) THEN 2230
2210  GO%(H3)=LAST%+1
2220  GOTO 2380
2230  IF GO%(H1)>GO%(H2) THEN 2290
2240  MK1=GO%(H1)
2250  MK2=GO%(H2)
2260  IF MK1< >1 OR MK2< >1 THEN GOTO 2310
2270  GO%(H3)=2
2280  GOTO 2380
2290  MK1=GO%(H2)
2300  MK2=GO%(H1)
2310  FOR I=1 TO Q
2320  IF I< >H3 THEN GOTO 2350
2330 GO%(I)=MK2
2340  GOTO 2370
2350  IF GO%(I)< =MK1 THEN 2370
2360  IF GO%(I)>MK1 THEN GO%(I)=GO%(I)+1
2370  NEXT I
2380  IF LAST%<5 THEN 2390
2390 LAST%=LAST%+1
2400 RETURN
2410 REM ********* FIND DISTANCE SUBROUTINE **********
2420 IF X1> =X2 THEN 2460
2430 XX2=X1
2440 XX1=X2
2450 GOTO 2480
2460 XX1=X1
2470 XX2=X2
2480 IF XX2 > 85 THEN 2510
2490 XD=DIST%(XX1,XX2)
2500 GOTO 2540
2510 XX=170-XX1
2520 YY=170-XX2
2530 XD=DIST%(XX,YY)
2540 RETURN
```

```
2550 REM ********** REPORT GENERATOR SUBROUTINE *************
2560 AAA$="##### ##### ##### ##### ##### ##### #####
     ##### ##### ##### ###"
2570 AAB$=" 1   2   3   4   5   6   7   8   9   10 "
2580 PRINT AAB$
2590 FOR I=1 TO 160 STEP 10
2600 PRINT USING AAA$;GO%(I);GO%(I+1);GO%(I+2);GO%(I+3);GO%(I+4);
     GO%(I+5);GO%(I+6);GO%(I+7);GO%(I+8);GO%(I+9);I
2610 NEXT I
2620 PRINT USING AAA$;GO%(I);GO%(I+1);GO%(I+2);GO%(I+3);GO%(I+4);
     GO%(I+5);GO%(I+6);GO%(I+7);GO%(I+8);I+10
2630 INPUT "LOC TO CHG (0 TO QUIT)";L0%
2640 IF L0%<=0 THEN 2680
2650 INPUT "VALUE";VA%
2660 GO%(L0%)=VA%
2670 GOTO 2580
2680 CLS
2690 PRINT TAB(30);"RECOMMENDED ETCHING IMPLEMENTATION PLAN"
2700 PRINT
2710 NUL$=""
2720 PRINT "PART I:  MOBILE ETCHING PROGRAM"
2730 AA$="!SITE  SITE          NUM OF COST OF  SAVINGS NET   DAYS
     COST TO"
2740 AB$="!NUMBER NAME         WEAPONS PROGRAM  ACCRUED
     SAVINGS AT SITE CEN ETCH"
2750 PRINT USING AA$;NUL$
2760 PRINT USING AB$;NUL$
2770 FOR I=1 TO Q
2780 FOR J=1 TO Q
2790 IF GO%(J)=I THEN 2820
2800 NEXT J
2810 GOTO 3090
2820 IF I=1 THEN R1=LAST% ELSE R1=I-1
2830 IF I=LAST% THEN R2=1 ELSE R2=I+1
2840 FOR II=1 TO Q
2850 IF GO%(II)=R1 THEN R1=II
2860 IF GO%(II)=R2 THEN R2=II
2870 NEXT II
2880 GET #1,J
2890 X1=J
2900 X2=R1
2910 GOSUB 2410
2920 D1=XD
2930 X2=R2
2940 GOSUB 2410
2950 D2=XD
2960 D5=(D1+D2)/2
2970 DAS=WPN%(J)\T+DO
2980 FOR LP=1 TO 169
2990 IF GO%(LP)>0 THEN W=W+WPN%(LP)
3000 NEXT LP
3010 EP=((BUY*3)/W)+F/T
3020 HH=J
3030 GOSUB 5250
```

```
3040 C=(D5*V)+(DAS*(CTDY+R))+(EP*N)+(CN*(N/TEL))+CNA
3050 SV=Y*12*CP*N*FI
3060 NET=SV-C
3070 AC$="### \          \\ ##### $$######.$$######.$$######.
     #### $$######."
3080 PRINT USING AC$;J;N1$;ST$;WPN%(J);C;SV;NET;DAS;CE(J)
3090 NEXT I
3100 GET #1,LCE%
3110 STOP
3120 PRINT:PRINT:PRINT
3130 IF LCE$="" THEN LCE$=N1$
3140 PRINT "PART II: CENTRAL SITE ETCHING PROGRAM AT ";LCE$
3150 AA$="!SITE  SITE          NUM OF  COST OF  SAVINGS  NET    DAYS"
3160 AB$="!NUMBER NAME         WEAPONS PROGRAM  ACCRUED
     SAVINGS  AT SITE"
3170 PRINT USING AA$;NUL$
3180 PRINT USING AB$;NUL$
3190 PRINT
3200 FOR E9=1 TO Q
3210 IF GO%(E9)<>-1111 THEN GOTO 3290
3220 GET #1,E9
3230 N=WPN%(E9)
3240 DAS=N\T
3250 SV=Y*12*CP*N
3260 NET=SV-CE(E9)
3270 AC$="### \          \\ ##### $$######.$$######.$$######.
     ####"
3280 PRINT USING AC$;E9;N1$;ST$;N;CE(E9);SV;NET;DAS
3290 NEXT E9
3300 PRINT:PRINT:PRINT
3310 STOP
3320 PRINT "PART III: SITES NOT COST EFFECTIVE
3330 AA$="!SITE  SITE          NUM OF  COST OF  SAVINGS  NET    DAYS"
3340 AB$="!NUMBER NAME         WEAPONS PROGRAM  ACCRUED
     SAVINGS  AT SITE"
3350 PRINT USING AA$;NUL$
3360 PRINT USING AB$;NUL$
3370 PRINT
3380 FOR E9=1 TO Q
3390 IF GO%(E9)>-9999 THEN GOTO 3470
3400 GET #1,E9
3410 N=WPN%(E9)
3420 DAS=N\T
3430 SV=Y*12*CP*N
3440 NET=SV-CE(E9)
3450 AC$="### \          \\ ##### $$#######.$$######.$$#######.
     ####"
3460 PRINT USING AC$;E9;N1$;ST$;N;CE(E9);SV;NET;DAS
3470 NEXT E9
3480 INPUT "IS THIS OK";TT$
3490 IF TT$="Y" THEN 3520
3500 IF TT$<>"N" THEN 3480
3510 GOTO 2550
3520 REM + + + + PRINT REPORT + + + +
```

```
3530 CLS
3540 LPRINT TAB(30);"RECOMMENDED ETCHING IMPLEMENTATION
     PLAN"
3550 LPRINT
3560 NUL$=" "
3570 LPRINT "PART I: MOBILE ETCHING PROGRAM"
3580 AA$="!SITE  SITE          NUM OF COST OF  SAVINGS NET   DAYS
     COST TO"
3590 AB$="!NUMBER NAME         WEAPONS PROGRAM  ACCRUED
     SAVINGS AT SITE CEN ETCH"
3600 LPRINT USING AA$;NUL$
3610 LPRINT USING AB$;NUL$
3620 EP=(BUY/W)+(F/T)
3630 FOR I=1 TO LAST%
3640 FOR J=1 TO Q
3650 IF GO%(J)=I THEN 3680
3660 NEXT J
3670 GOTO 3950
3680 IF I=1 THEN R1=LAST% ELSE R1=I-1
3690 IF I=LAST% THEN R2=1 ELSE R2=I+1
3700 FOR II=1 TO Q
3710 IF GO%(II)=R1 THEN R1=II
3720 IF GO%(II)=R2 THEN R2=II
3730 NEXT II
3740 GET #1,J
3750 X1=J
3760 X2=R1
3770 GOSUB 2410
3780 D1=XD
3790 X2=R2
3800 GOSUB 2410
3810 D2=XD
3820 D5=(D1+D2)/2
3830 DAS=WPN%(J)\T+DO
3840 FOR LP=1 TO 169
3850 IF GO%(LP)>0 THEN W=W+WPN%(LP)
3860 NEXT LP
3870 EP=((BUY/3)/W)+F/T
3880 HH=J
3890 GOSUB 5250
3900 C=(D5*V)+(DAS*(CTDY+R))+(EP*N)+(CN*(N/TEL))+CNA
3910 SV=Y*12*CP*N*FI
3920 NET=SV-C
3930 AC$="### \          \\\ ##### $$#######.$$#######.$$#######.
     #### $$#######."
3940 LPRINT USING AC$;J;N1$;ST$;WPN%(J);C;SV;NET;DAS;CE(J)
3950 NEXT I
3960 GET #1,LCE%
3970 STOP
3980 LPRINT:LPRINT:LPRINT
3990 IF LCE$="" THEN LCE$=N1$
4000 STOP
4010 LPRINT "PART II: CENTRAL SITE ETCHING PROGRAM AT ";LCE$
4020 AA$="!SITE  SITE          NUM OF COST OF  SAVINGS NET   DAYS"
```

```
4030 AB$="!NUMBER NAME          WEAPONS PROGRAM   ACCRUED
SAVINGS  AT SITE"
4040 LPRINT USING AA$;NUL$
4050 LPRINT USING AB$;NUL$
4060 LPRINT
4070 FOR E9=1 TO Q
4080 IF GO%(E9)<>-1111 THEN GOTO 4160
4090 GET #1,E9
4100 N=WPN%(E9)
4110 DAS=N\T
4120 SV=Y*12*CP*N
4130 NET=SV-CE(E9)
4140 AC$="### \          \\ ##### $$######.$$######.$$######.
     ####"
4150 LPRINT USING AC$;E9;N1$;ST$;N;CE(E9);SV;NET;DAS
4160 NEXT E9
4170 LPRINT:LPRINT:LPRINT
4180 STOP
4190 LPRINT "PART III: SITES NOT COST EFFECTIVE
4200 AA$="!SITE  SITE          NUM OF  COST OF   SAVINGS NET    DAYS"
4210 AB$="!NUMBER NAME          WEAPONS PROGRAM   ACCRUED
     SAVINGS  AT SITE"
4220 LPRINT USING AA$;NUL$
4230 LPRINT USING AB$;NUL$
4240 LPRINT
4250 FOR E9=1 TO Q
4260 IF GO%(E9)>-9999 THEN GOTO 4340
4270 GET #1,E9
4280 N=WPN%(E9)
4290 DAS=N\T
4300 SV=Y*12*CP*N
4310 NET=SV-CE(E9)
4320 AC$="### \          \\ ##### $$#######.$$######.$$#######.
     ####"
4330 LPRINT USING AC$;E9;N1$;ST$;N;CE(E9);SV;NET;DAS
4340 NEXT E9
4350 RETURN
4360 H=29999
4370 GOSUB 4390
4380 GOSUB 4670
4390 REM *** FIND NEXT NODE SUBROUTINE ***
4400 FOR A=1 TO Q
4410 IF GO%(A) < 1 THEN GOTO 4650
4420 IF GO%(A) > = LAST% THEN GOTO 4470
4430 FOR B=1 TO Q
4440 IF GO%(B)=GO%(A)+1 THEN 4480
4450 NEXT B
4460 PRINT "ERROR *** LINE 2110 ***":END
4470 B=START%
4480 FOR J=1 TO Q
4490 IF GO%(J)<=-1111 OR GO%(J)>0 THEN GOTO 4640
4500 X1=J
4510 X2=A
4520 GOSUB 2410
```

```
4530 D1 = XD
4540 X2 = B
4550 COSUB 2410
4560 D2 = XD
4570 X1 = A
4580 D = D1 + D2-XD
4590 IF D > = H THEN GOTO 4640
4600 H = D
4610 H1 = A
4620 H2 = B
4630 H3 = J
4640 NEXT J
4650 NEXT A
4660 RETURN
4670 REM *** CALCULATE ROUTING SUBROUTINE ***
4680 DATA 0,0,0,0,0,0,0,0,0,0,0
4690 READ DD1,DD2,DD3,DD4
4700 DI = 100000!
4710 RESTORE
4720 READ V91,V92,V93,V94
4730 A = 2
4740 FOR I = 1 TO 169
4750 FOR J = -A TO A
4760 IF LAST% + J > LAST% THEN B = J ELSE B = LAST% + J
4770 IF GO%(I) = B THEN RST(J + A + 1) = I
4780 NEXT J
4790 NEXT I
4800 FOR V91 = 2 TO 4
4810 PRINT "4101 V91 = ";V91
4820 X1 = RST(1)
4830 X2 = RST(V91)
4840 IF X2 = 0 THEN 5200
4850 GOSUB 2410
4860 DD1 = XD
4870 FOR V92 = 2 TO 4
4880 PRINT "4161 V92 = ";V92
4890 IF V92 = V91 THEN 5180
4900 X1 = RST(V91)
4910 X2 = RST(V92)
4920 IF X2 = 0 THEN 5180
4930 GOSUB 2410
4940 DD2 = XD
4950 FOR V93 = 2 TO 4
4960 PRINT "4231 V93 = ";V93
4970 IF V93 = V92 THEN 5170
4980 IF V93 = V91 THEN 5170
4990 X1 = RST(V92)
5000 X2 = RST(V93)
5010 IF X2 = 0 THEN 5170
5020 GOSUB 2410
5030 DD3 = XD
5040 X1 = RST(V93)
5050 X2 = RST(5)
5060 GOSUB 2410
```

```
5070 DD4=XD
5080 D99=DD1+DD2+DD3+DD4
5090 PRINT "4801 DI=";DI;" D99=";D99
5100 IF DI<=D99 GOTO 5170
5110 DI=D99
5120 ANSWER(1)=RST(1)
5130 ANSWER(2)=RST(V91)
5140 ANSWER(3)=RST(V92)
5150 ANSWER(4)=RST(V93)
5160 ANSWER(5)=RST(5)
5170 NEXT V93
5180 NEXT V92
5190 NEXT V91
5200 FOR J=-A TO A
5210 IF LAST%+J>LAST% THEN B=J ELSE B=LAST%+J
5220 GO%(ANSWER(J+A+1))=B
5230 NEXT J
5240 RETURN
5250 REM *** COST/BENEFIT SUBROUTINE ***
5260 N=WPN%(HH)
5270 GET #1,HH
5280 IF SERV$(HH)<>"MC" THEN 5330
5290 CNA=6700*CVI(S$)+8200*CVI(D$)
5300 CP=.305
5310 FI=1
5320 TEL=1000
5330 IF SERV$(HH)<>"AM" THEN 5380
5340 CNA=0
5350 CP=.203
5360 FI=4.33
5370 TEL=500
5380 IF SERV$(HH)<>"AS" THEN 5430
5390 CNA=0
5400 CP=.203
5410 FI=.166
5420 TEL=500
5430 IF SERV$(HH)<>"AT" THEN 5480
5440 CNA=0
5450 CP=.203
5460 FI=.166
5470 TEL=500
5480 IF SERV$(HH)<>"AA" THEN 5530
5490 CNA=0
5500 CP=.203
5510 FI=.333
5520 TEL=500
5530 IF SERV$(HH)<>"AL" THEN 5580
5540 CNA=0
5550 CP=.203
5560 FI=.166
5570 TEL=500
5580 IF SERV$(HH)<>"AF" THEN 5630
5590 CNA=0
5600 CP=.203
```

```
5610 FI=4.33
5620 TEL=500
5630 RETURN
```

APPENDIX C

RECOMMENDED M16 ETCHING PROGRAM

(U.S. MARINE CORPS /U.S. AIR FORCE)

This appendix describes the M16 laser-etching program, produced by the SALEM model described in Appendix B, that we have recommended for the U.S. Marine Corps and the U.S. Air Force.

Table C-1 describes the portion of the overall program that is to be conducted by using a mobile, truck-mounted laser etcher to visit cost effective sites. It provides not only a listing of the installations to be visited but also details the costs and savings of the program for that installation. The table lists each site in the order in which it would be visited by the etcher to obtain the results described. However, the routing is circular and as long as the order of visits is maintained, the program may be begun at any of them.

Table C-2 gives cost and benefit information for Edwards Air Force Base, which is the only installation for which it is more economical to etch at a central facility (i.e., the Air Force small arms maintenance facility at Hill Air Force Base, UT).

Table C-3 summarizes the cost and benefit figures for the complete program.

TABLE C-1

MOBILE ETCHING PROGRAM

Routing Sequence	Location	Service	Active Weapons at Site	Cost to Etch	Inventory Savings Per Year
1	Hanscom AFB, MA	AF	326	$ 1,548	$ 3,439
2	Boston, MA	MC	543	2,995	1,987
3	New York City, NY	MC	1,639	5,359	5,999
4	Philadelphia, PA	MC	666	1,829	2,438
5	Middletown, PA	AF	602	2,373	6,350
6	McGuire AFB, NJ	AF	568	2,261	5,991
7	Dover AFB, DE	AF	265	1,606	2,795
8	Andrews AFB, MD	AF	678	3,595	7,152
9	Quantico MCB, VA	MC	9,802	7,177	35,875
10	Norfolk, VA	MC	2,806	14,242	10,270
11	Pope AFB, NC	AF	571	2,527	6,023
12	Camp Lejeune, NC	MC	32,544	116,475	119,111
13	Charleston AFB, SC	AF	361	1,205	3,795
14	Charleston, SC	MC	510	914	1,867
15	Garden City, GA	AF	149	530	73
16	Parris Is. MCB, SC	MC	13,771	48,235	50,402
17	Patrick AFB, FL	AF	447	2,425	4,715
18	Eglin AFB, FL	AF	3,270	13,494	34,492
19	New Orleans, LA	MC	646	2,661	2,364
20	Dallas, TX	MC	864	3,297	3,162
21	Kirtland AFB, NM	AF	1,180	5,486	12,447
22	Yuma MCAS, AZ	MC	1,231	3,158	4,506
23	29 Palms MCB, CA	MC	4,586	10,690	16,785
24	San Diego MCB, CA	MC	12,346	33,638	45,186
25	Norton AFB, CA	AF	1,123	4,165	11,845
26	Camp Pendleton, CA	MC	35,590	135,610	130,259
27	Travis AFB, CA	AF	426	2,321	4,493
28	San Francisco, CA	MC	1,327	3,936	4,857
29	Moffett Field, CA	AF	249	1,698	2,626
30	Seattle, WA	MC	585	2,470	2,141
31	Nanaimo, BC	AF	788	4,234	8,312
32	Scott AFB, IL	AF	518	3,173	5,464
33	Springfield, IL	AF	435	2,264	4,588
34	Chicago, IL	MC	723	2,135	2,646
35	Toledo, OH	AF	488	2,365	5,147

TABLE C-2

CENTRAL ETCHING PROGRAM

Location	Service	Active Weapons at Site	Cost to Etch	Inventory Savings Per Year
Edward AFB, CA	AF	399	$2,738	$4,209

TABLE C-3

SUMMARY M16 BAR CODE LASER ETCHING PROGRAM

(U.S. Marine Corps/U.S. Air Force)

Service	Cost of Program	Inventory Savings Per Year	Payback Period
U.S. Marine Corps	$ 434,821	$ 439,855	0.99 year
U.S. Air Force	60,008	133,955	0.45 year
Total	$ 494,829	$ 573,811	0.86 year